Integration of satellite image and LiDAR data to determine damaged buildings after the earthquake based on support vector Machine Algorithm in Haiti

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Extended abstract

Introduction

Given the population growth and increasing urbanization, the occurrence of natural disasters like earthquake can cause heavy losses and damages and interrupt the development of cities and countries. Among these disasters, the earthquakeisof great importance due to its unpredictability and high frequency in relation to other events, as well as its location on the earthquake belt. According to the last year's estimate, Iran has been one of the 6 countries with high mortality rates in earthquakes. Therefore, finding a way to minimize the losses can be critical. Crisis managers need quick information from the affected area after the earthquake to minimize the fatalities and financiallosses. The destruction map is one of the information that helps crisis managers. These maps show the destructed buildings or roads with their degree of destruction. With these maps, the destructed buildings and roads can be found quickly.

Materials & Methods

Many methods are used to prepare the destruction maps, such as aerial/satellite images, LiDAR data, etc. These information can be used to determine the destructed buildings automatically or by visual interpretation. Visual interpretation for determining the degree of destruction requires operator. Although this method has high accuracy, it is less considered because it is time consuming and needs specialists to interpret the data. Therefore, researchers have focused on automated processing techniques for the production of the destruction maps. Various automatic change detection techniques are used to evaluate the destruction resulting from earthquakeby comparing satellite images in two pre and post-earthquake periods based on satellite and aerial images. LiDARdata is one of the most important sources of information to determine destructed buildings with high accuracy and speed. LiDAR data provides the possibility of 3-D demonstration of the destructed region. This information is a great help in preparing the destruction map automatically. The recent expansion of the LIDAR technology is due to the high spatial power of these data. As a result, many researchers have focused on developing an automatic destruction map using Lidar data.Although considering the textural information from the Lidar data, like homogeneity in the destructed region can be effective in distinguishing between the destroyedand undestroyed buildings.

In this paper, a new algorithm is proposed to prepare the destruction map after the earthquake by integratingthe post-event high resolution satellite images and post-event LiDAR data. In the proposed method, different textural

descriptors of the LiDAR image and data are extractedafter the necessary preprocessing on the satellite image andLiDAR data after the earthquake. In the next step, using the layer of buildings extracted from the map,the areas of the buildings are extracted from the satellite image and LiDAR data, as well as the satellite image descriptors and LiDAR data.Then, the textural descriptorsextracted from the satellite image and LiDAR data are combinedtogether. After that, the points inside this area are categorized into two classes of "debris" and "intact" by the method of support vector machine. Finally, based on the area of the debris class of each building, destroyed and undestroyed buildings were identified by taking a threshold limit into consideration. This algorithm is executed on each building from the destruction part to produce the final destruction map

Results&Discussion

In order to evaluate the proposed method,the data set was selected from the city of Port-au-Prince, the capital of Haiti, after the 2010 earthquake. According to the USGS reports, 97,294 buildings were damaged and 188,383 were destroyed in Port-au-Prince and most of the southern parts of Haiti. Furthermore, reports show that 222,570 people were killed, 300,000 were injured, and 1.3 million people were displaced. The sample data set include post-event WorldView II satellite images as well as post-event LiDAR data. The WorldView II satellite took images on January, 16 2010, and the LiDAR date was also obtained from this topography website. Obtaining LiDAR data is from January, 21 2010 to January, 27 2010. The vector map of the selected test area was generated in ArcGIS environment. By evaluating the proposed method and using the existing data, the overall accuracy of 97% and the Kappa coefficient of 92% were obtained which proved the reliability of this technique.

Conclusion

In this paper, a new method for the generation of damage map based on the integration of high resolution satellite images and LiDAR data was proposed. The results show the ability of this method in generating destruction maps based on the satellite images with high resolution and LiDAR data. In comparing similar studies, the results are satisfactory. The selection of the appropriate descriptors, correct training data, the elimination of non-building areas from the sample data, the integration of satellite images and LiDARdate can be known as the reason behind obtaining these results.

Keywords: Earthquake, Satellite image, LiDAR data, Support Vector Machine, Destruction map